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**Evaluation of Real-time Feedback to Train Caregivers
to Conduct Early Intensive Behavioral Interventions**

by

Amanda L. Gibson

A DISSERTATION

Presented to the Faculty of

University of Nebraska Medical Center's Munroe-Meyer Institute

in Partial Fulfillment of the Requirements

for the Degree of Doctor of Philosophy

Medical Sciences Interdepartmental Area Graduate Program

Applied Behavior Analysis

Under the Supervision of Professor William J. Higgins

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July, 2017

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**Evaluation of Real-time Feedback to Train Caregivers
to Conduct Early Intensive Behavioral Interventions**

Amanda L. Gibson, Ph.D.

University of Nebraska Medical Center, 2017

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Mounting empirical support for early intensive behavioral intervention (EIBI) has increased demand for these types of treatments for children diagnosed with autism spectrum disorder (ASD). Many caregivers are now learning EIBI techniques and becoming active agents in their child's ASD treatment. Behavioral skills training (BST) has been frequently used to teach individuals to perform a variety of skills correctly, including discrete-trial instruction (DTI; Lafasakis & Sturmey, 2007). In this study, caregivers were trained to conduct a DTI procedure. A single-component BST method (i.e., real-time feedback) was examined. A concurrent, multiple baseline across caregivers design was used to demonstrate experimental control. Results showed that a single-component BST was associated with short training time and few sessions to mastery. In addition, caregivers expressed high satisfaction with the real-time feedback training method.

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LIST OF ABBREVIATIONS

ABA	Applied Behavior Analysis
ADOS™-2	Autism Diagnostic Observation Scale
ASD	Autism Spectrum Disorder
ASRS™	Autism Spectrum Rating Scale
BST	Behavioral Skills Training
DTI	Discrete-Trial Instruction
DTT	Discrete-Trial Teaching
EIBI	Early Intensive Behavioral Intervention
IRB	Institutional Review Board

Evaluation of Real-time Feedback to Train Caregivers to Conduct Early Intensive Behavioral Interventions

Autism spectrum disorder is a neurodevelopmental disorder that results in significant functional limitations in social interactions and communication, impaired adaptive behaviors, impaired speech and language development, and persistent repetitive behaviors and restricted interests (American Psychiatric Association, 2013). The most current prevalence rates of ASD are approximately one in 68 children (United States Centers for Disease Control and Prevention, 2015). Recent research suggests that the earlier the child receives intervention, the better the long-term prognosis (Maglione, Gans, Das, Timbie, & Kasari, 2012; Woods & Wetherby, 2003). Substantial gains for a large number of children can be achieved because of EIBI services, which are based on the principles and procedures of applied behavior analysis (ABA) and are a comprehensive approach to the treatment of young children with ASD (Eikeseth, Smith, Jahr, & Eldevik, 2002; Lovaas, 1987; Sallows & Graupner, 2005). Key findings from an outcome study investigating EIBI services for children with ASD suggested improvements can be observed across several domains, including academic achievement, adaptive behavior, intelligence, and problematic behavior (Sallows & Graupner, 2005). Additionally, EIBI has been shown to aid in the development of functional skills and improve the overall level of functioning of children diagnosed with ASD (Peters-Scheffer, Didden, Korzilius, & Sturmey, 2011; Sallows & Graupner, 2005).

Many disadvantaged toddlers with ASD are currently only receiving less than half of the recommended intervention hours each week; therefore, it is vital that caregivers be trained to implement EIBI services in the home to enable their children to make substantial progress (Durkin et al., 2010; Irvin, Byun, Meece, & Farmer, 2012; Liptak et al., 2008). The National Survey of Children's Health found that children who are African American, Latino, or economically disadvantaged have disproportionately less access to services (Durkin et al., 2010; Irvin, et al., 2012; Liptak et al., 2008). The cost of EIBI services for ASD over the lifespan is 3.2 million dollars per person (Ganz, 2007). The cost of lifelong care can,

however, be reduced by two-thirds with early diagnosis and EIBI services (U.S. Government Accountability Office, 2007). It is recommended that children receive between 30-40 hours of intervention per week for the best long-term prognosis (Behavior Analyst Certification Board, 2015). Therefore, since caregivers spend a significant portion of time with their children, it is important to evaluate the extent to which they can use EIBI strategies correctly and consistently.

The most common solution to this problem is to teach caregivers to assist in the implementation of treatment protocols. Caregiver training in community-based settings has been established as a feasible alternative to approximate more closely the recommended hours of EIBI treatment for toddlers with an ASD (Brookeman-Frazee, Stahmer, Lewis, Feder, & Reed, 2012; Heitzman-Powell, Buzhardt, Rusinko, & Miller, 2014; Smith, Buch, & Gamby, 2000). Additionally, since early intervention services for children with ASD are limited, especially for underprivileged families like those served in many community-based clinics, it is important to find alternative training methods that can be utilized in home settings due to significant travel time and costs related to center-based ABA and caregiver training services.

Behavioral Skills Training

Behavioral skills training (BST) is commonly used to teach a wide variety of skills, including DTI (Lafasakis & Sturmey, 2007). Several common behavioral skills training components, such as written instructions, role-play, rehearsal, and feedback, are used to train caregivers (Miltenberger, 2007). With written instructions, the protocol is typically given to caregivers to read and review. This usually serves as a baseline measure when different BST component packages are being assessed. Verbal instructions consist of a therapist reading a protocol aloud, explaining each item and then answering any questions the caregiver may have. Modeling may also be used; this typically involves two therapists role-playing each scenario that may arise in a treatment session and answering any questions from the caregiver at the end. It may also involve the caregiver watching a video of a therapist performing the protocol.

Role-play or rehearsal is another common training component in which the caregiver carries out the protocol while the trainer plays the role of a child and vice versa (Miltenberger, 2007). Finally, feedback may be given either in-vivo or after an observation. In-vivo feedback involves a trainer accompanying a caregiver during an observation and giving praise for correctly performed skills and offering behavior specific feedback for any steps in the protocol performed incorrectly as they occur. Verbal post-session feedback, in which a trainer will review both correct and incorrect performances with the caregiver after an observation, may also be used. Or, the caregiver may watch a video of a session in which he or she performed the skills, and the trainer provided information relating to steps performed correctly and incorrectly throughout the video. A multi-component BST package, including various combinations of verbal instructions, modeling, rehearsal, and feedback, is often used to increase the procedural integrity of caregivers implementing ABA protocols (Miltenberger, 2007). While numerous BST packages have been shown to be effective in teaching a variety of skills (e.g., child abduction [Johnson et al., 2005], gun safety [Miltenberger, 2008], DTI [Sarokoff & Sturmey, 2004], and pediatric feeding protocols [Anderson & McMillan, 2001]), these packages are frequently time and resource intensive, with training time lasting between 2-18 hours outside of actual training sessions.

Numerous studies have shown that providing caregivers with written instructions or protocols is not sufficient to promote high levels of treatment integrity for a variety of skills, such as DTI and feeding protocols (Lafasakis & Sturmey, 2007; Mueller, et al., 2003; Seiverling, Williams, Sturmey, & Hart, 2012). This is consistent with the educational theory of learning as depicted by Bloom's Taxonomy (Bloom, 1956). Bloom's Taxonomy categorizes levels of thinking and learning into six hierarchical steps, with knowledge forming the base and lowest level of learning. Two higher levels of the taxonomy include application and synthesis, both of which require individuals to apply and utilize information in specific situations and demonstrate mastery of given skills (Bloom, 1956). Behavioral

skills training requires caregivers to demonstrate mastery of the EIBI skills to ensure they can apply the skill in a variety of settings and under various situations.

Only one published study to date has examined the effectiveness of feedback alone to increase positive parent-child interactions within a large-n study design (Shanley & Niec, 2010). Therefore, additional research is needed to determine whether feedback alone is a viable training procedure, specifically for teaching caregivers to implement EIBI programs. If feedback alone proves to be equally effective as BST packages, this would allow for more frequent caregiver training sessions, reduced costs associated with center-based travel and training, and more time to teach caregivers other skills important to their children's development and progress. It is relevant to examine feedback alone as a teaching strategy because real-time verbal feedback incorporates several common BST components within the context of actual training sessions. For example, it may include immediate reinforcement for correct responses, verbal modeling of appropriate responses following an error (i.e., "Next time, when he plays nicely with the car, say, 'You are playing with the car so well!'", and shaping of appropriate responses over time. It may also include rehearsal as caregivers practice the skill repeatedly while receiving verbal feedback regarding their performance of specific skills. These behavioral mechanisms in combination may prove to be an effective and efficient strategy for training caregivers to implement EIBI skills with high levels of treatment integrity.

It is important for behavior analysts to evaluate caregiver treatment integrity because caregivers will ultimately serve as behavior change agents in the natural environment. Two studies have examined the effects of poor treatment integrity on rates of child acquisition and levels of problem behavior. Holcombe, Wolery, and Snyder (1994) compared the effects of a procedure delivered with high procedural fidelity and a procedure delivered with low integrity (e.g., included errors related to presentation of a controlling prompt) on six preschoolers' acquisition of receptive identification of photographs. Within an adapted alternating treatments design, the results showed that the children learned more rapidly when the teachers

delivered the procedures with high treatment integrity. Additionally, training time was significantly lower in the high-fidelity conditions. More recently, DiGennaro and Martens (2007) examined levels of problem behavior under varying levels of treatment integrity of teachers' implementation of function-based treatment protocols. Results showed a significant positive correlation between treatment integrity and problem behavior such that high levels of treatment integrity were associated with lower levels of problem behavior.

Multi-component BST packages have been used to increase the procedural integrity of caregivers implementing ABA protocols in several studies (Bakken, Miltenberger, & Schauss, 1993; Lafasakis & Sturmey, 2007; Mueller, et al., 2003). To illustrate, Barnard, Christophersen, and Wolf (1977) showed that a multi-component caregiver training package was effective in training caregivers to teach their children to behave appropriately in supermarkets. The training package utilized praise, verbal feedback, token economy, and punishment components, to intervene on behavioral excesses (e.g., touching items, elopement) in the supermarket. Kuhn, Lerman, and Vorndran (2003) trained caregivers to implement individualized treatments for their children's problem behavior using various BST components, including written instructions, verbal instructions, role-play, and immediate feedback during performance of targeted skills. Training time lasted between two to three hours in duration for each caregiver. Finally, Ben Chaabane, Alber-Morgan, and DeBar (2009) trained caregivers with a multi-component package (e.g., instructions, modeling, practice, and feedback) to implement a picture exchange system with their children. While the results of all three studies demonstrated caregivers' ability to implement the treatment with high levels of integrity following training, specifics regarding length of training time were not discussed. Specific descriptions regarding caregiver training components and caregiver behaviors measured were also limited; therefore, it is difficult to determine the feasibility and costs of these BST package treatments. Furthermore, lack of specific details regarding caregiver behaviors also limits the ability of other researchers to replicate the procedures in future studies.

Within the larger behavioral literature, real-time feedback has been systematically evaluated and has been proven effective in training caregivers to implement behavioral protocols without other BST components. Real-time feedback (also known as in-situ or in-vivo feedback) can be defined as verbal prompting provided by trained therapists to caregivers moment by moment as the caregiver implements a protocol or procedure. The primary difference between real-time feedback and post-observation or BST feedback is that real-time feedback is provided while the caregiver implements each component of a protocol whereas post-observation feedback occurs after a given amount of time has passed for time-based procedures or at the end of a trial or multiple trials for trial-based procedures. Shanley and Niec (2010) examined the effects of utilizing real-time feedback to increase positive caregiver-child interactions in 60 mothers with children ages 2-7 years old. The mothers were divided into two groups: real-time feedback or a no feedback control group. Real-time feedback consisted of modeling (providing the mothers with an example of a positive play behavior), reinforcement (praise following positive play behaviors), and correction (description of how to perform a positive play behavior next time). The no feedback control group did not receive any training. During baseline, no significant differences in the number of positive parent behaviors were observed between the real-time feedback and no feedback groups. Following the real-time feedback intervention, the mothers in the real-time feedback group showed a significant increase in positive parent behaviors compared to initial baseline levels and the no feedback group. These results suggest that real-time feedback alone may be effective to train caregivers in applied settings.

Discrete-Trial Instruction

Since its development by Lovaas in the 1980s, DTI has served as an essential component of EIBI programs for children with autism (1987). DTI is a method of instruction that breaks down skills into smaller components to make learning easier for children with developmental disabilities (Smith, 2001). It is also known as discrete-trial teaching (DTT). A “discrete-trial” can occur within a matter of seconds and can be used to teach a variety of

skills, such as receptive and expressive language, augmentative communication, motor imitation, discrimination skills, and any form of new behavior (Smith, 2001).

DTI has been shown to be an effective method of teaching skills to children with a variety of developmental disabilities. Downs, Downs, Johansen, and Fossum (2007) demonstrated the effectiveness of DTT instruction with 12 children in a public-school classroom. Children in the DTT instruction group received 30-42 hours of DTT instruction over the course of 27 weeks. Children assigned to the matched control group received their regularly scheduled classroom teaching during the study. The results showed that the children in the DTT instruction group demonstrated significant gains in the areas of adaptive behavior, language skills, behavioral functioning, and social-emotional functioning compared to the children in the control group. Another study by Gutierrez et al. (2009) compared the effectiveness of two DTI procedures to teach receptive language skills to young children with ASD. Using an adapted alternating treatments design, the experimenters taught three participants a variety of receptive language (i.e., identification of objects, actions, shapes, and colors). The results showed that all three participants rapidly acquired all trained receptive skills for both DTI teaching procedures.

Although DTI has a body of literature to support its use to teach EIBI skills, it often proves to be highly labor intensive and requires specialized training. Research has demonstrated the importance of caregivers' involvement in their children's ongoing treatment; therefore, it is important to evaluate the extent to which they can implement DTI with high integrity (Crockett, Fleming, Doepke, & Stevens, 2007).

Caregiver Implemented DTI

Several empirical studies have evaluated the extent to which BST packages have been effective in teaching staff and caregivers how to implement DTI. Crockett, Fleming, Doepke, and Stevens (2007) examined the effectiveness of 12-18 hours of intensive training that included written and verbal instructions, modeling, role-play, and feedback to caregivers during their implementation of DTI in a multiple-baseline design across child skills. During

baseline, both caregivers performed below mastery criteria. Following the training package, both caregivers could effectively implement DTI across multiple skills with high integrity (Crockett et al., 2007).

Lafasakis and Sturmey (2007) also examined the effectiveness of a BST package on parent implementation of discrete-trial teaching. When provided with only written instructions alone during baseline sessions, parents were not able to implement the gross-motor and vocal imitative programs with high treatment integrity. However, following the component training package involving instructions, modeling, and feedback, both parent and child responding increased to acceptable and high levels. However, no caregiver training data, such as length of time and integrity, were shown or discussed.

Single Component Interventions

Several studies have examined a single-component intervention to train staff to implement DTI. Arnal et al. (2007) utilized a self-instruction manual to determine its effectiveness in training students to conduct DTI with simulated children with ASD. Four students with no prior history of DTI were given written instructions detailing the tasks they were to perform. All four students performed at or below 60% during all three baseline sessions. Next, all students were provided with a 21-page instruction manual detailing the specifics of DTI to review at their own pace. The students were then required to master study questions related to the DTI material. Following the self-instruction treatment, each student was asked to perform the DTI tasks with a confederate child (i.e., a therapist role playing a child). The self-instruction manual alone did not improve performance to mastery levels (average of 67%); therefore, an additional video scoring component and feedback on the scoring were added to the training package. After receiving the additional training components, all three students implemented DTI tasks with high integrity (at or above 80%).

The results of Arnal et al. (2007) demonstrated that self-instruction materials alone were not sufficient to train students to implement DTI, and the addition of the video scoring (caregivers used a 19-point checklist to score therapist treatment integrity) and feedback

component was necessary for high treatment integrity of the DTI procedure. It is unclear which of the three components was responsible for the change in responding from baseline to treatment; however, given that the self-instruction manual only increased responding to 67% on average, it is likely that the feedback component served as an important mechanism of behavior change and may have been effective alone since it was needed to demonstrate clinically acceptable levels of responding.

Catania, Almeida, Liu-Constant, and Reed (2009) also examined a single component treatment to train staff to implement DTI, specifically video modeling. Within a multiple baseline design across participants, the researchers evaluated the effects of a 7-min video to increase correct implementation of DTI skills. Results showed that the video model alone was sufficient to train staff to implement DTI, and staff skills also generalized to other tasks and maintained over time (1-week follow-up). More recently, Vladescu, Carroll, Paden, and Kodak (2012) examined the efficacy of video modeling plus voiceover instructions on staffs' ability to implement a DTI procedure. Using a concurrent multiple baseline design across staff members, the researchers demonstrated the effectiveness of two video models on three staff members' accurate implementation of DTI protocols. Results also generalized to two new DTI programs. However, both studies provided caregivers with detailed written protocols during baseline sessions. Written instructions alone may have had an additive effect, along with the video models; therefore, the effects of the video model alone cannot be determined. Future research should examine the effects of a single-component treatment without the presence of written instructions during baseline.

Purpose

Due to the growing number of children diagnosed with autism within the United States, there has been a simultaneous increase in demand for EIBI services for children diagnosed with ASD. Because many disadvantaged toddlers with ASD are currently only receiving 50% or less than the recommended intervention hours each week due to shortages in trained professionals to provide effective services, many caregivers are now learning EIBI

techniques and becoming active agents in their children's ASD treatment. BST has been frequently used to teach individuals to perform a variety of skills correctly, including DTI. Although BST packages have been used to train caregivers in effectively implementing other skills, they can often be time and resource intensive to utilize in clinic-based settings. Few studies have examined the effectiveness of single component BST training to teach DTI, a common EIBI component. Due to many barriers related to access to treatment, such as time, money, and resources, it is important to empirically evaluate less intrusive training procedures, like real-time feedback. It is also important to evaluate the extent to which caregivers can implement EIBIs to ensure children with ASD are receiving effective services and learning at a rapid rate. Moreover, efficiency (e.g., training time) and social acceptability of training are important aspects of treatment that must be evaluated.

The purpose of this experiment was to: 1) evaluate the effectiveness and efficiency of real-time feedback alone to train caregivers to implement a DTI procedure, 2) to demonstrate caregiver maintenance and generalization of the DTI skills, and 3) measure the social validity of the training procedure to determine if it was an acceptable and feasible teaching strategy.

CHAPTER 1: METHOD

Participants

Four caregivers of children with ASD participated in the study. None of the caregivers had any prior training or experience with implementing DTI. The lead experimenter collected the following information from caregivers prior to the start of the study: age, gender, highest level of education, educational area(s) of study, early intervention training or experience, current living situation, and mental health or physical health concerns.

Cora (age 28) was the biological mother of 4-year-old Avery. Cora held a bachelor's degree in business. Avery had an ASD diagnosis and had been receiving EIBI services at a rural Midwest clinic for approximately three years. Avery resided with his biological parents.

Ana (age 47) was the mother of 4-year-old son Eli. Ana held a bachelor's degree in accounting. Eli had been diagnosed with ASD and displayed receptive and expressive language delays. Eli resided with his biological mother and father and had been receiving EIBI services at a rural Midwest clinic for approximately one year.

Tara (age 49) and Ken (age 52) were the maternal grandparents of 4-year-old Saul. Tara received her associate's degree from a community college. Ken had a high school education. Saul had been diagnosed with ASD at the age of 2 and had been receiving EIBI services at a rural Midwest clinic for approximately two years. Saul permanently resided with his biological grandparents.

Settings and Materials

Sessions were conducted in a 1.83 x 2.4 m room at a center-based ASD community-based early intervention treatment facility. Materials present in the treatment room included several highly-preferred toys. Preference of toys was established using a 5-min free-operant preference assessment prior to the beginning of each caregiver training session (Roane, Vollmer, Ringdahl, & Marcus, 1998). Other materials present in the room included program items, such as a cube chair desk, data sheet, clipboard, writing utensil, timer, flashcards, and 3D objects that served as targets for each child. All sessions were video recorded for data collection purposes.

Caregiver Inclusion and Exclusion Criteria

A caregiver was included in the study if he/she met the following criteria:

1. The caregiver was between the ages of 19 to 80 years old. This age range for adult caregivers was selected because the caregivers must have been at least 19 years of age to sign the parental consent form and must have been physically and cognitively capable of implementing the treatment recommendations.
2. The caregiver was a parent or guardian of a child currently enrolled at a Midwest Early Intervention Clinic.

3. The caregiver spoke English as a primary language (as determined by self-report). This inclusion criterion was selected because training materials were only available in English and the experimenters of the current study only spoke English.
4. The caregiver did not have any prior training related to DTI or other similar early intervention program skills.

A caregiver was excluded from the current study if:

1. The caregiver was not between the ages of 19 to 80 years old.
2. The caregiver was not a parent or guardian of a child who was currently enrolled at a Midwest Early Intervention Clinic.
3. The caregiver did not speak English as a primary language.
4. The caregiver had previously received training related to DTI.

Three children diagnosed with an ASD who were enrolled in a Midwest Early Intervention community-based program also participated in the study. DTI sessions were conducted frequently (i.e., multiple times daily) as a component of each child's regularly scheduled EIBI services; thus, each child had experience participating in DTI sessions prior to the start of this study but did not have experience with the programs and targets utilized during the study.

Child Inclusion and Exclusion Criteria

A child was included in the study if he met the following criteria:

1. Child was between the ages of 2 and 5 years old. This age range was selected because it was the current age range of all children enrolled in the Midwest Early Intervention Clinic.
2. The child was currently enrolled at the Midwest Early Intervention Clinic.
3. The child had a verified diagnosis of ASD as determined by the following diagnostic measures: Autism Diagnostic Observation Scale (ADOS™-2; overall score in clinically significant range), Autism Spectrum Rating Scale (ASRS™), clinical observation, and

clinical interview. All diagnoses were provided by a licensed psychologist who was also a Board Certified Behavior Analyst (BCBA).

4. The child had a generalized imitation repertoire. This criterion was selected to ensure that the child participants could respond to a model prompt that was a key component of the DTI graduated guidance procedure. Imitation skills were probed prior to the start of the study.

A child was excluded from the current study if:

1. He was not between the ages of 2 to 5 years old.
2. He was not currently enrolled in the Midwest Early Intervention Clinic.
3. He did not have a verified diagnosis of ASD.
4. He did not have a generalized imitation repertoire.

Institutional Review Board Consent

Verbal and written consent were given by caregivers before they and their children participated in the caregiver training evaluation via completion of an Institutional Review Board's (IRB's) parental consent form. The consent form was reviewed in person with all caregivers and signed prior to the start of sessions. The experimenter (i.e., lead author) and another BCBA supervisor at the clinic conducted all training sessions. Both held a master's degree in behavior analysis and were BCBA's working toward a doctorate degree in applied behavior analysis.

Experimental Design

A concurrent multiple baseline design across caregivers was utilized (Baer, Wolf, & Risley, 1968) to evaluate the acquisition of caregiver skills when taught to implement a DTI session block using real-time feedback alone. Baseline sessions were conducted until stability was obtained (i.e., limited variation and no trend in the data path across at least three consecutive data points).

Response Measurement and Interobserver Agreement

Caregiver behavior: measurement. During the study, data were collected using a pen and paper data collection system by trained therapists. The percentage of steps implemented correctly for each 5-trial session was calculated by totaling all the steps in each trial performed correctly and dividing that number by the total number of steps that had the opportunity to occur (e.g., excluded all steps that were not applicable). Mastery criterion during real-time feedback was set at 90% or above for three consecutive sessions such that the caregiver was required to perform three, 5-trial sessions at 90% or higher to move to post-training, maintenance, and generalization phases of the study. The 90% mastery criterion was selected to ensure that caregivers could implement the DTI protocol with high treatment integrity (i.e., three or fewer errors per 5-trial session).

Caregiver behavior: definitions. During each session, data were collected on caregiver responding across all experimental conditions. The primary dependent measure was the percentage of target steps performed correctly per 5-trial session. Caregivers' responses included (a) preparing for table time, defined as having all necessary items to run the program; (b) presenting pictures or cards correctly, defined as placing cards/items directly in child's visual field and presenting appropriate number of cards/items; (c) establishing ready behavior, defined as waiting to present the instruction until the child made eye contact with caregiver for at least 1 s; (d) presenting the correct instruction, defined as presenting the correct verbal prompt one time only; (e) implementing the graduated guidance procedure correctly, defined as moving from a verbal, to demonstration, to full physical prompt as needed based on child responding and waiting 5 s between each prompt before providing a more intrusive prompt; (f) reinforcing an independent correct response with praise and a tangible item, defined as providing verbal praise, along with brief access to a tangible item, to the child following an independent correct response within 5 s of the correct response; (g) reinforcing a prompted response, defined as providing brief verbal praise following a prompted response; (h) delivering a reinforcer for the appropriate time period, defined as providing brief access to a high-preference tangible item for the allotted time period (10-15 s)

following an independent correct response; (i) providing the appropriate inter-trial interval, defined as waiting 1-5 s after the reinforcement interval has expired and removing/reordering teaching materials before delivering the next instruction; (j) recording data, defined as circling the child's response on the data sheet prior to giving the next instruction; and (k) calculating the percentage of correct child responses, defined as summing the number of correct responses, dividing that number by five, and multiplying that number by 100 at the end of each 5-trial session.

Additional dependent measures collected included session duration (in min) and total training time, calculated by summing the session duration of all real-time feedback sessions until the caregiver met the mastery criterion. Frequency of errors was also calculated by summing the number of errors for each 5-trial session. Trial-by-trial percentages were also calculated for the first 20 and last five trials of real-time feedback, which was calculated by summing the number of correctly implemented steps, dividing that by the total number of steps that had the opportunity to occur, and multiplying that number by 100.

Child behavior. Frequency data were collected on child responding during each 5-trial session. Child responses included (a) independent correct responses, defined as providing a correct vocal/ or gestural response or correct visual perceptual skill within the allotted delay, (b) prompted responses, defined as a correct response following a model or physical prompt from a caregiver, or (c) error, defined as providing an incorrect response. All dependent measures were converted to a percentage by dividing the number of trials with the correct occurrence of a target behavior by the total number of trials in the session (five) and multiplying that number by 100.

Observer Training and Interobserver Agreement

Prior to the onset of the study, all data collectors completed a data collection training by watching and scoring a brief simulated DTI session. All data collectors were trained to a criterion of 90% or higher. It took observers an average of three sessions to achieve mastery of data collection skills.

Two observers independently scored caregiver behavior during at least 60% of sessions across all experimental conditions for each participant. IOA was calculated using an exact agreement coefficient across all dependent variables within each session. The primary and secondary observers' data were compared on a step-by-step basis for each step during each trial. An agreement was defined as both observers scoring the same response, and a disagreement was defined as one observer scoring one response and the second observer scoring a different response. An interobserver agreement (IOA) score was calculated by dividing the number of agreements by the number of agreements plus disagreements and converting the quotient to a percentage for each 5-trial session. Exact agreement was 95% (range, 80% to 100%) during the training evaluation for all caregivers. The mean IOA scores across all sessions were 94% (range 80-100%), 96% (range, 87-100%), 95% (range 89-100%), and 94% (range 85-100%) for Cora, Ana, Tara, and Ken, respectively. IOA was scored for 74%, 73%, 77%, and 69% of sessions for Cora, Ana, Tara, and Ken, respectively.

Procedural Integrity

Procedural integrity was collected by having an observer score the therapist's implementation of the specified feedback procedures on a step-by-step basis for 100% of sessions for all participants during real-time feedback sessions. During each trial, *accurate feedback* for a step was scored if the therapist provided praise following a correctly implemented step at least twice per trial (10 praise statements per session minimum). For each praise statement under the specified criteria (10), *inaccurate feedback* was scored (e.g., if only 8 praise statements were provided, the general praise component would have been recorded as 8 out of 10 or 80%). *Accurate feedback* was also scored if the therapist provided behavior specific feedback following each incorrect implementation of the protocol. If the therapist did not provide behavior specific feedback when it should have been provided, *inaccurate feedback* was scored. Additionally, *accurate feedback* was scored if the therapist provided behavior specific praise on the next opportunity if the caregiver engaged in a correct response after receiving behavior specific feedback on a previous trial. If the therapist did not

provide behavior specific praise following a caregiver error correction, *inaccurate feedback* was also scored.

Observers scored the frequency of opportunities in which feedback was correctly provided for each trial. The experimenter then calculated a treatment integrity percentage by totaling the number of opportunities during a session in which feedback was provided correctly (accurate feedback) and dividing that number by the total number of opportunities in a session that feedback should have occurred but did not (inaccurate feedback) plus the number of opportunities in which feedback was provided correctly (accurate feedback) and multiplied that number by 100. Exact agreement for procedural integrity was 95% (range, 87% to 100%) during real-time feedback sessions for all caregivers. The mean procedural integrity scores across all real-time feedback sessions were 95% (range 88-100%), 97% (range, 91-100%), 94% (range 87-100%), and 96% (range 90-100%) for Cora, Ana, Tara, and Ken, respectively. Procedural integrity data were collected on 100% of real-time feedback sessions.

IOA was also scored on the therapist's feedback behavior during 50% of feedback sessions. IOA was calculated using an exact agreement coefficient across all dependent variables within each session. The primary and secondary observers' data were compared on a step-by-step basis for each item in a trial (i.e., each of the caregiver dependent measures). An agreement was defined as both observers scoring the same response, and a disagreement was defined as one observer scoring one response and the second observer scoring a different response. An interobserver agreement (IOA) score was calculated by dividing the number of agreements by the number of agreements plus disagreements and converting the quotient to a percentage for each 5-trial session. Exact agreement was 88% (range, 82% to 95%) during the training evaluation for the therapist. The mean procedural integrity IOA scores across all sessions were 85% (range 82-89%), 88% (range, 84-92), 88% (range 87-89%), and 90% (range 87-95%) for Cora, Ana, Tara, and Ken, respectively.

General Procedures

When caregivers arrived to training sessions, a container with the materials (e.g., see Setting and Materials) necessary to participate in caregiver training was available. All sessions lasted until five trials had been completed.

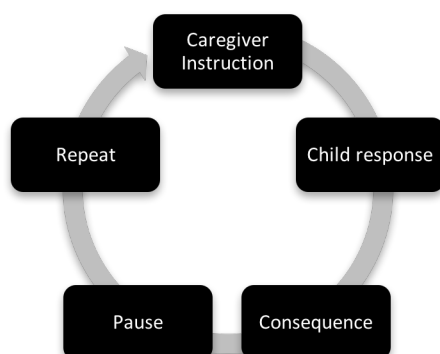
Child baseline probes. Prior to initial baseline sessions, caregivers were provided with a simple internet description of DTI (See Table 1 for a sample), along with a one-sentence description of the targets and skill area they were to teach. A therapist was present during each session but did not provide any feedback regarding correct or incorrect implementation of skills. Caregivers were given 5 min to review the description. No questions from caregivers were answered during this phase. Caregivers were then asked to perform one or two, 5-trial sessions with their actual child. Only one or two probe sessions were conducted with the actual child to avoid repeated exposures to incorrect caregiver responding that could negatively affect child acquisition of the targeted skills. Caregivers

Table 1

Sample DTI Receptive Identification of Actions Description

Caregivers can use discrete-trial instruction (DTI) to teach their child new skills.

DTI has four main steps: (1) caregiver's instruction, (2) the child's response, (3) consequence for correct or incorrect response, and (4) a short pause before the next instruction. We would consider these four steps one "instruction."



Please teach your child how to identify (by pointing or giving the card) the following **ongoing actions** to the best of your ability: **kicking ball, boy jumping, and girl sliding.**

were also instructed not to practice the DTI skills outside of sessions until the conclusion of the study.

Confederate baseline probes. Following the initial baseline sessions with the actual child, caregivers were then asked to perform all additional baseline sessions with a confederate therapist. These sessions were included to ensure that the caregiver would be given the opportunity to perform appropriately given all possible child responses (i.e., correct, error, no response, or no ready behavior) that may occur during a DTI session. A therapist was present during each session but did not provide feedback. No questions from caregivers were answered during this phase. Caregivers were not transitioned to the training phase until stability was achieved during baseline probe sessions. During baseline, if the caregiver had scored at or above 90% on the DTI protocol, the caregiver would have been terminated from the study since he/she had already met the mastery criterion. However, no caregivers met mastery criterion during the baseline phase.

Training (with confederate). All caregivers were then asked to perform DTI sessions while a therapist provided real-time feedback until the caregivers could perform the skill at the mastery criterion. These sessions served to evaluate the effect of the training procedure on the caregivers' ability to conduct the core components of DTI. All training sessions were conducted with a confederate therapist to ensure that caregivers could provide appropriate prompting following all potential child responses (i.e., correct, error, no response, or no ready behavior). Training was discontinued after caregivers correctly performed at least 90% on the component skills during at least three consecutive training sessions with a confederate (mastery criterion). For each 5-trial session, the lead experimenter randomly predetermined confederate responding to ensure all responses that could occur during a trial were sampled across sessions. The confederate was given a list describing the five pre-determined responses for each session prior to the start of each session. In addition to programming in varied confederate responses (e.g., correct, responding after model, and responding after a full

physical prompt), the therapist also programmed in error responses as well as diverted eye gaze (ready behavior) during randomized trials each session.

Real-time feedback. A therapist was present during each session and provided immediate feedback regarding correct/incorrect use of DTI skills with a confederate therapist. For each DTI session, *behavior specific feedback* was provided following every error of omission or commission given there was an opportunity for feedback to be provided (e.g., an error/omission in the protocol occurred). The behavior specific feedback typically suggested what the caregiver should do if the child emitted that specific behavior again in the future. The feedback did not state that the caregiver had performed the procedure incorrectly. For example, if a caregiver did not use the instruction provided on the caregiver data sheet, the therapist said, “In the future, say, ‘Give me the car’ when delivering the instruction to the child.” Often, caregivers corrected the error following feedback (e.g., rehearsed the correct response) and then continued to the next step in the trial. If the caregiver made the same error on two trials in a row, the therapist provided the behavior specific feedback in the form of a reminder, “Remember to use the instruction provided on your data sheet.”

During each instruction, the therapist also provided brief *general praise* regarding correct protocol delivery, such as “That was perfect” or “You’re working really hard!” at least twice per trial. A range of praise statements during all feedback sessions was calculated for each caregiver by totaling all praise statements provided (excluding the behavior specific praise following error corrections) for each session and calculating the minimum and maximum values. The range of praise statements per session was 16-29, 17-30, 16-27, and 17-24 for Cora, Ana, Tara, and Ken, respectively. While the frequency of praise statements varied from session to session, at least 10 praise statements were provided during each 5-trial session for all caregivers.

Behavior specific verbal praise following error corrections was given to the caregiver if he/she corrected an error during the next opportunity after receiving feedback on that specific error from a previous trial. For example, if the caregiver delivered a prompt too soon

during the first instruction but appropriately waited the correct duration of time during the fourth instruction, the therapist said, “Nice work waiting 5 s before modeling the correct response” during the fourth instruction. For some of the DTI steps, there was not an opportunity to give behavior specific feedback because that step only occurred once during the 5-trial session (e.g., calculating the percentage of correct child responses at the end of the 5 trials). If the therapist could not provide behavior specific praise during the current 5-trial session, the therapist attempted to provide behavior specific praise for that error correction during the next 5-trial session. If the caregiver asked a question regarding feedback delivered during a trial, the therapist responded to it and prompted the caregiver to continue through the trial. If the question could not be answered briefly, the therapist provided additional clarification at the end of the session.

Program Skills. Skills selected for training were determined based on each child’s specific programming needs and included receptive identification, matching, listener responding feature, function, or class skills (LRFFC), and tracing. One skill area was selected for each child during training (e.g., receptive identification of objects). See Table 2 for a list of all programs and targets selected for each child. Three targets for each skill were randomly preassigned on each caregiver data sheet to avoid potential noncompliance with mass trial instruction of a single target (e.g., receptive identification of penny, dime, and quarter rather than just penny).

Termination Criterion. If after two hours of real-time feedback, a caregiver had not yet reached mastery criterion, he/she would have been terminated from the study. This time was determined by examining the minimum amount of time a BST package could be delivered based on previous research. If training time exceeded two hours, the real-time feedback procedure would not have been more efficient than typical BST packages, which was one of the main purposes of the study. However, training time never exceeded two hours for any caregiver.

Post-training probes (confederate). Once caregivers met the mastery criterion during the training phase within a given skill area, post-training probe sessions with the confederate were conducted to assess caregivers' performance in the absence of experimenter feedback.

During the post-training probes, the experimenter was present in the session room but did not provide feedback on any of the target skills. Mastery criterion for post-training probes was 90% or above.

Table 2

List of Programs and Targets Selected for Each Child

Child's Name (Caregiver)	Phase	Program Area	Target 1	Target 2	Target 3
Avery (Cora)	Teaching	Receptive Math	1+1	1+2	1+3
	Gen 1	Receptive Math	2+1	2+2	2+3
	Gen 2	ID of strangers, friends, family	Mom	Classmate	Unfamiliar person
	Gen 3	Spatial Positions	Left	Right	Center
Eli (Ana)	Teaching	Receptive ID of Actions	Kicking	Sliding	Jumping
	Gen 1	Receptive ID of Actions	Swimming	Coloring	Zippering
	Gen 2	ID of Item Function	What do you drive?	What do you shake?	What do you stack?
	Gen 3	Associations	Toothbrush & toothpaste	Socks & shoes	Soap & sink
Saul (Tara)	Teaching	Receptive ID of Time (whole hours)	1 o'clock	5 o'clock	8 o'clock
	Gen 1	Receptive ID of Time (whole hours)	2 o'clock	6 o'clock	9 o'clock
	Gen 2	MTS (Written time to analogue clock)	3 o'clock	7 o'clock	10 o'clock
	Gen 3	Tracing Letters	A	O	T
Saul (Ken)	Teaching	Receptive ID of Coin Values	Penny (1 cent)	Quarter (25 cents)	Dime (10 cents)
	Gen 1	Receptive ID of Coin/Dollar Values	Nickel (5 cents)	\$1 (one dollar)	\$5 (five dollars)
	Gen 2	Match to Sample (Equivalent Amounts)	5 pennies = 1 nickel	2 nickels = 1 dime	5 nickels = 1 quarter
	Gen 3	Receptive Math	1+1	1+2	1+3

Post-training probes (child). If the caregiver maintained mastery of the protocol during the post-training probes with the confederate, additional post-training probe sessions were conducted to assess the caregiver's performance with his/her actual child. During the post-training probes, the experimenter was present in the session room but did not provide feedback on any of the target skills.

Maintenance. Maintenance sessions were conducted after the post-training probes were completed with the caregivers. Two maintenance assessments were conducted with the caregivers one week (M1) and two weeks (M2) following initial training sessions, except for Cora's maintenance sessions, which occurred at one and three weeks.

Generalization 1. Following maintenance 1 sessions (one week after initial training was conducted), the therapist provided caregivers with three novel targets to teach their child within the same program area that was used during training (G1). This was to ensure that caregivers would continue to be able to teach their children new targets in the absence of therapist feedback.

Generalization 2 and 3. Following the two-week maintenance check, a simple written description of two novel DTI programs (G2 [similar program] and G3 [dissimilar program]) were provided to caregivers. Caregivers were given 5 min to review the descriptions for each program, one at a time. No questions from caregivers were answered during this phase. Caregivers were then asked to perform two, 5-trial sessions with their actual child for each of the new generalization programs (i.e., if a caregiver first learned how to teach a receptive skill, one of the new programs may have focused on visual perceptual skills in the form of a matching to sample task and the other may have been a tracing program). No feedback on accuracy of implementation of the procedures was provided by the experimenter until after the conclusion of the experiment.

Social validity questionnaire. Following the generalization probes, all caregivers were invited to complete a social validity questionnaire. Caregivers could respond to each of the questionnaire items by circling a number on a Likert scale from 1-7, in which 1 =

“Strongly Disagree/Dissatisfied” to 7 = “Strongly Agree/Satisfied.” Space was provided for elaboration on responses.

CHAPTER 2: RESULTS

Figure 1 displays the percentage of DTI steps performed correctly during baseline, training, post-training, maintenance, and generalization probes for all four caregivers. During the baseline condition (i.e., child and confederate baselines), all caregivers implemented DTI at a low percentage: Cora ($M = 15\%$), Ana ($M = 8\%$), Tara ($M = 3\%$), and Ken ($M = 46\%$). Real-time feedback alone resulted in an immediate and robust increase in the caregivers' correct implementation of DTI. Once caregivers performed at least 90% of the DTI skills correctly across three sessions, post-training probes were conducted with the confederate and caregiver's actual child. Following four to seven training sessions, all caregivers correctly conducted at least 90% of the DTI skills correctly. Two weeks following initial training, three caregivers maintained mastery on all trained skills (90% or above performance). All caregivers also performed at moderate to high levels on the generalization protocols.

The results for Cora are depicted in the top panel of the multiple-baseline design graph in Figure 1. During baseline, Cora implemented the DTI protocol for mathematical addition at low levels with both Avery and the confederate ($M = 15\%$). During real-time feedback, Cora's correct implementation of the DTI protocol steps for mathematical addition increased to high and stable levels ($M = 89\%$, range 56-97%). Following seven feedback sessions, Cora met the mastery criterion. Cora's total training time to mastery was 20 min. Cora's correct implementation of the DTI protocol steps for mathematical addition remained at high and stable levels when feedback was removed during post-training sessions with both the confederate and Avery ($M = 97\%$, range 92-100%), as well as during all maintenance sessions ($M = 99\%$, range 94-100%). Generalization probes were conducted with two new programs: identification of strangers and spatial positions. Cora continued to perform at high levels on both generalization programs ($M = 94\%$, range 89-97%).

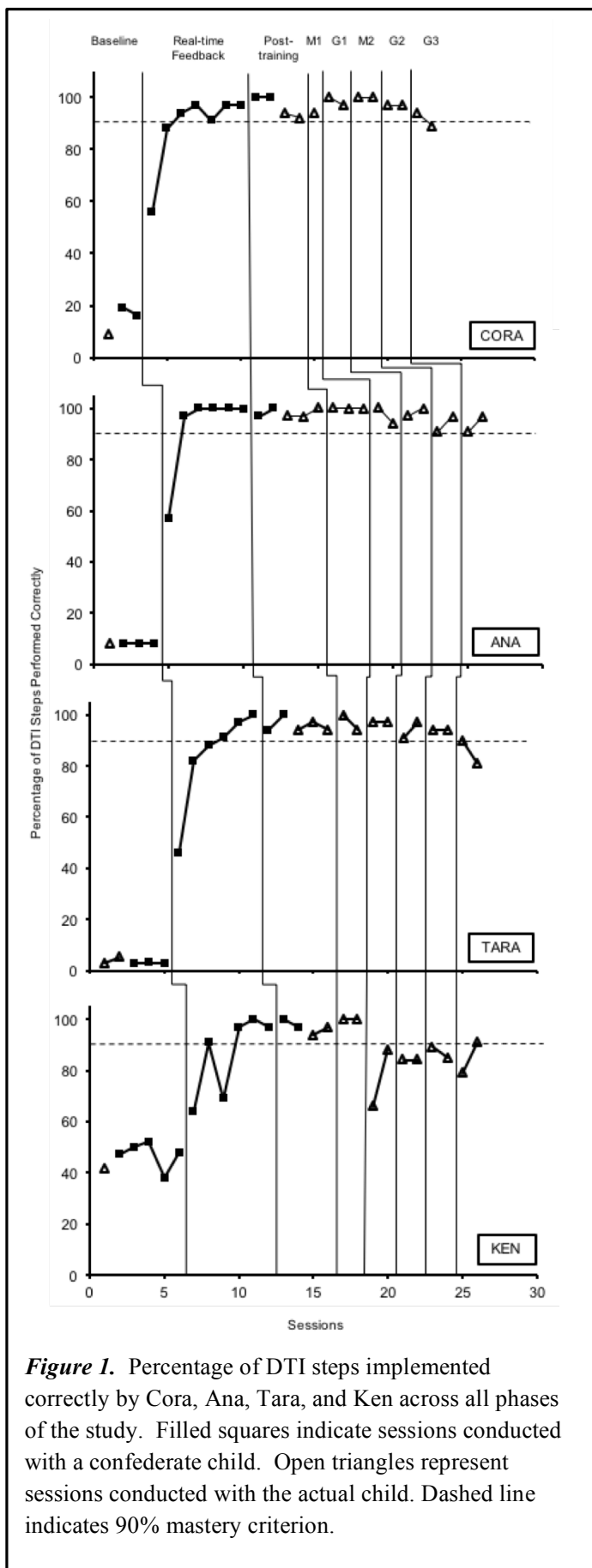


Figure 1. Percentage of DTI steps implemented correctly by Cora, Ana, Tara, and Ken across all phases of the study. Filled squares indicate sessions conducted with a confederate child. Open triangles represent sessions conducted with the actual child. Dashed line indicates 90% mastery criterion.

The results for Ana are depicted in the second panel of Figure 1. During baseline, Ana implemented the DTI protocol for identification of actions at near zero levels with both Eli and the confederate ($M = 8\%$). During real-time feedback, Ana's correct implementation of the identification of actions program increased to high and stable levels ($M = 92\%$, range 57-100%). Following only four feedback sessions, Ana met mastery criterion. Ana's total training time to mastery was 26 min. Ana's correct implementation of the DTI protocol remained at high and stable levels when feedback was removed during post-training sessions with both Eli and the confederate ($M = 98\%$, range 97-100%), as well as during all maintenance sessions ($M = 99\%$, range 97-100%). During the two generalization programs, identification of item functions and item associations, Ana continued to perform the protocols at high and stable levels ($M = 96\%$, range 91-100%).

Tara's results are depicted in the third panel of Figure 1. Tara implemented the DTI protocol on identification of whole hour times at near zero levels ($M = 3\%$) during all baseline sessions. Tara's correct implementation of the DTI protocol on time increased to high and stable levels ($M = 83\%$, range 46-100%) after receiving six real-time feedback sessions. Tara's total training time to mastery was 25 min. Tara's correct implementation of the DTI protocol on time remained at high and stable levels when feedback was removed during post-training sessions with both Saul and the confederate ($M = 96\%$, range 94-100%), as well as during all maintenance ($M = 96\%$, range 91-100%) sessions. Tara's generalization programs consisted of a match to sample task related to time and a letter tracing program. Tara performed the generalization programs at moderate levels during these sessions ($M = 90\%$, range 81-94%). Tara's percentage of correct DTI skills was higher on the MTS program, which was more like the initial identification of time program, than the tracing program. During the tracing generalization probes, Tara did not follow the prompt sequence correctly (i.e., moving to a model or full physical prompt when needed) that she was trained to implement during real-time feedback sessions. Anecdotally, after the study, the therapist

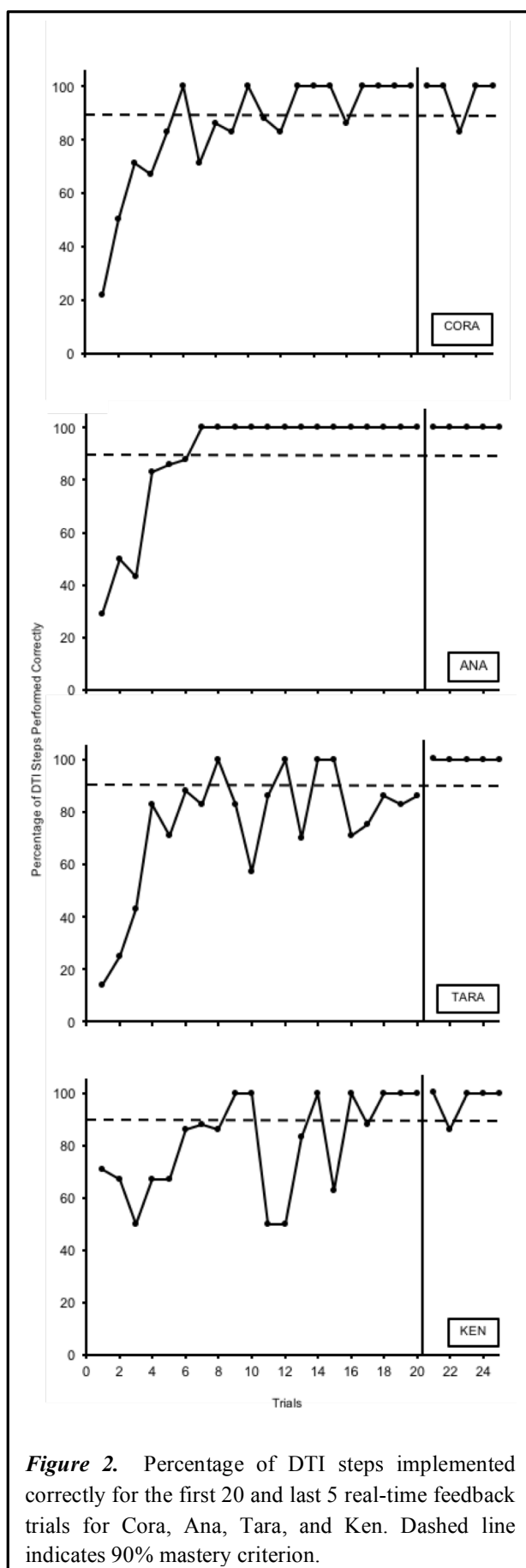
provided a brief verbal reminder about the steps of the prompting procedure, and Tara was able to demonstrate mastery of the tracing protocol without any further training.

Finally, Ken's results are depicted in the bottom panel of Figure 1. Ken implemented the DTI protocol on identification of coin values at moderate levels during baseline ($M = 46\%$). After receiving real-time feedback, Ken's correct implementation of the DTI protocol increased to high and stable levels ($M = 86\%$, range 64-100%). Following six real-time feedback sessions, Ken met the mastery criterion. Ken's total training time to mastery was 37 min. Ken's correct implementation of the DTI protocol remained at high and stable levels when feedback was removed during post-training sessions with both Saul and the confederate ($M = 97\%$, range 94-100%), as well as during his 1-week maintenance sessions ($M = 100\%$). Ken performed at moderate levels during his 2-week maintenance sessions due to repeating the instruction multiple times, presenting too many cards in the array, and not providing a model prompt within 5 s of the initial instruction ($M = 84\%$). During the first generalization 1 session, Ken's performance dropped significantly below mastery for one of the two sessions (66%). However, during the second generalization 1 session, his performance was almost at mastery (88%). During his generalization 2 probes, Ken scored just below mastery levels ($M = 87\%$, range 85-89%). Like Tara, Ken performed at lower levels during his final generalization probes (generalization 3), which was a mathematical addition program that was dissimilar to the identification of time program for which he was initially provided feedback ($M = 85\%$, range 79-91%). Overall, Ken's maintenance and generalization data were variable.

Figure 2 displays trial-by-trial data for all four participants. These data show a rapid acquisition curve during the first 20 trials with real-time feedback and a stable pattern of responding for each participant during the last 5 trials.

Figure 3 depicts the session duration and frequency of errors for each session for Ana. Ana's results were selected because they were representative of each caregiver's pattern of responding. During baseline, sessions typically lasted between 3-4 min for all caregivers. Frequency of errors occurred at a high rate (30 or more errors per 5-trial session). During the

first two real-time feedback sessions, session duration doubled to approximately 6-7 min.



However, as caregivers' integrity increased, session duration returned to baseline levels of approximately 3-4 min. Following real-time feedback sessions, frequency of errors decreased to near zero levels and remained low during maintenance and generalization sessions. These patterns were similar across all caregivers.

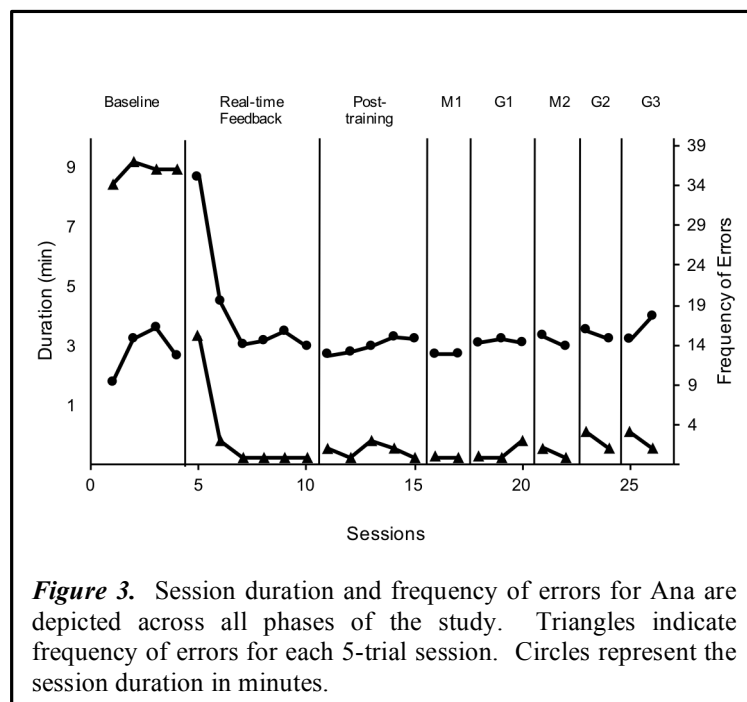


Figure 3. Session duration and frequency of errors for Ana are depicted across all phases of the study. Triangles indicate frequency of errors for each 5-trial session. Circles represent the session duration in minutes.

The results of the social validity questionnaire are summarized in Table 3. In general, the caregivers rated their training experience highly and were satisfied with the feedback component as indicated by mean ratings between 6.25 and 7. All four caregivers rated their overall training experience as satisfactory. Caregivers reported that they would recommend this type of real-time feedback training to other caregivers and would be willing to be trained

Table 3

Social Validity Questionnaire Data from Caregivers

Social Validity Questions 1 = strongly disagree; 7 = strongly agree	Caregiver Responses				Means
	Cora	Ana	Tara	Ken	
Satisfied with the caregiver training?	7	7	7	7	7
Satisfied with how feedback was provided?	7	7	7	7	7
Comfortable during training?	7	6	6	7	6.5
Confident in ability to implement DTI programs?	7	6	6	6	6.25
Willing to be trained on other ABA procedures?	7	7	7	7	7
Recommend training to other caregivers?	7	7	7	7	7
Will you use the DTI programs at home?	7	7	7	7	7

on other protocols using the same feedback method in the future. Together, the efficacy and social validity results show that the training procedure was feasible and effective for all four caregivers, and they each rated the training experience positively.

Discussion

Based on the findings of the current study, real-time feedback proved to be an effective and efficient procedure to train four caregivers to implement behavioral interventions for their children with ASD. After only four to seven feedback sessions, all caregivers could implement their designated DTI protocol at high and stable levels. High levels of caregiver treatment integrity were maintained by all caregivers one week after initial training. Furthermore, all caregivers generalized their DTI training to other similar programs with moderate to high levels of accuracy. Average training time for each caregiver was only 27 min (range 20-37 min). When compared to typical BST component packages that have been shown to last between 2-18 hours to deliver outside of actual sessions, this intervention proved to be a more efficient delivery method (Anderson & McMillan, 2001; Johnson et al., 2005; Miltenberger, 2008; Sarokoff & Sturmey, 2004). By reducing overall training time, more time may be devoted to training caregivers on other programs, training additional caregivers, and reducing the overall costs associated with caregiver training.

After examining the social validity data, caregivers rated the real-time feedback as highly satisfactory (moderately to strongly agreed with all questions). The feedback procedure may have been perceived as being uncomfortable by caregivers due to the nature of the behavior specific feedback; however, while caregivers commented that at times they were slightly uncomfortable, they stated that it was only because the skills they were learning were new and not because of any aspect of the training or feedback. One caregiver stated that having written instructions would have been helpful to reference during the training; however, they were not necessary for mastery of the DTI protocol. Another caregiver commented that she was “always more confident when receiving immediate feedback or answers to

questions.” Furthermore, a third caregiver stated, “This training is paramount in the growth of my little guy. The more training I receive, the better I will get, and the faster he can learn.”

The real-time feedback intervention utilized in the current study contained several components: behavior specific feedback, general praise, and behavior specific praise following error corrections. The results of this study showed that all three feedback components led to a robust increase in correct caregiver implementation of the DTI protocols following feedback delivery. However, it is unknown whether all three feedback components were essential, specifically the general praise statements. There was also a rich schedule of praise provided during each 5-trial real-time feedback session (range 16-30). It is important to note, however, that despite transitioning from a rich to lean schedule of praise during post-training sessions, three caregivers were still able to maintain high protocol accuracy two weeks after training. Future research should more closely examine the schedule of praise delivery to determine the most effective and efficient frequency of praise.

While the real-time feedback alone proved to be an effective intervention for the caregivers that participated in the evaluation, the specific behavioral mechanisms involved remain unclear. Praise statements may have served as positive reinforcers for correct caregiver responding. Negative reinforcement may have also served as a behavioral mechanism by which caregivers may have attempted to avoid behavior specific feedback by implementing the protocol components correctly following feedback. Additionally, the behavior specific feedback may have served as a positive punisher based on the significant reduction in errors following feedback. Following behavior specific feedback, most caregivers attempted to correct the error (e.g., after receiving feedback for presenting too many cards in the array, the caregiver would remove the extra cards before delivering the instruction) and then proceed to the next step of the protocol even though not directly instructed to do so. This embedded rehearsal component (i.e., repeatedly practicing the correct response) may have also contributed to the rapid acquisition of correct caregiver responding during training.

Anecdotally, following only one instance of behavior specific feedback on some components of the protocol (i.e., calculating child percentage at the end of the session), caregivers did not err on that component again. However, on other protocol components, such as delivering the instruction only one time and removing and reordering the program stimuli between each trial, most caregivers required behavior specific feedback on those specific steps multiple times. Future research should examine the relationship between natural caregiver behaviors (e.g., repeating instructions multiple times) and protocol errors of commission and omission that occur in the context of caregiver training.

Another notable difference during this study compared to previous caregiver training research was the absence of written instructions during baseline sessions. Most caregiver training studies provide caregivers with a detailed written protocol prior to baseline sessions. By providing caregivers with written instructions, researchers cannot determine the individual effect of the independent variable in isolation, but are rather only able to draw conclusions based on the combination of the written instructions and the independent variable(s). The results of the current study demonstrated the effectiveness of a *single* BST component, which renders it the first known study to date to demonstrate this effect within the behavioral literature. By eliminating the typical written instructions baseline, we can conclude that the real-time feedback alone was effective in increasing caregiver treatment integrity to high levels.

By eliminating several common BST components (written instructions, pre-session modeling, and pre-session rehearsal), real-time feedback alone as a training method may be more conducive to remote caregiver training sessions where an onsite trainer may not be available to model and rehearse the programmed skills with caregivers. While the current study utilized a confederate during training sessions, future research should examine the effectiveness of real-time feedback when all sessions are conducted with an actual child. Real-time feedback may then be used to provide telehealth training to families who are not

able to receive in-clinic or in-home services due to long wait lists and limited board certified providers.

Although the study included a wide range of caregivers, both parents and grandparents of children with ASD, one limitation was that all three child participants were approximately four years old and had received at least one year of EIBI services. Because the child participants had been receiving EIBI services for extended periods of time, minimal problem behavior occurred during DTI sessions. Therefore, the current study did not program for significant instances of problem behavior that may occur during DTI sessions with younger children or children who have not received EIBI services in the past. Future research should examine the effectiveness of real-time feedback with children who have not received EIBI services, as well as include trials in which caregivers are required to address problem behavior appropriately in the context of teaching.

A second limitation of the current study was that the researchers did not control the number of DTI sessions that caregivers had previously observed in the clinic. If past caregiver observation would have had a substantial effect on the caregivers' ability to perform the DTI protocol, it would have been expected that the caregivers would have implemented the protocols with higher accuracy during baseline sessions. No caregiver performed the DTI protocol at acceptable levels during baseline; therefore, it is unlikely that past caregiver observation had a significant effect on caregivers' performances. Future studies should control for and examine the extent to which caregiver observation of DTI has any effect on caregiver skill acquisition.

One final limitation of the current study was the focus on receptive, visual performance, and writing skills. No expressive language tasks were included in the current study due to the differences in prompting strategies for receptive and expressive language; therefore, future research should examine the effectiveness of real-time feedback when teaching caregivers how to implement expressive language tasks, daily living programs, and social skills.

Regardless of these limitations, the results of the current study provide support for the effectiveness of real-time feedback alone to train the caregivers in this study to assist with behavioral interventions for their children with ASD. In addition, these four caregivers' positive responses to their training lends it even more promise as a means of equipping them to become an integral force in the effort to treat their children with ASD. Moreover, because the results of this study demonstrated that real-time feedback was effective and feasible, these procedures have the potential to be used via telehealth to provide more frequent caregiver training sessions and reduce the costs associated with center-based travel and training. Ultimately, enabling caregivers to implement EIBI services in the home will concurrently enable their children with ASD to realize substantial and meaningful progress.

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